Empowering rural south Odisha: a clean energy entrepreneurship approach for sustainable development

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Abstract. The current paper focuses on the process of developing clean energy entrepreneurs to facilitate the abundant adoption of clean energy products in rural areas of South Odisha, India. Southern part of the state of Odisha, is characterized by its rich cultural and ecological diversity significance, and it faces the challenges of energy access which subsequently leads to slowing down the socio-economic development of the region. Background: The present study focuses on developing a framework on the role of clean energy entrepreneurs in adoption of clean energy technology or the clean energy products and also further it also focuses on design and development of a solar operated Agri-pesticide sprayer. Method: A case study method is used to, identify the major barriers to clean energy adoption in the rural regions of South Odisha and also explore the different entrepreneurial steps undertaken to overcome the challenges. Moreover, the paper also focuses on the collaborating efforts between the local entrepreneurs, government agencies, and various non-profit organizations so as to create a supportive ecosystem for achieving sustainable development. Results: The findings of the study aims to inform policy makers, Government, etc. that there is a need to collaborate in order to adopt clean energy products so that it will help in paving a way for achieving sustainable development.

Key Words: Clean energy entrepreneurs; Solar operated Agri-pesticide sprayer; Rural development; Sustainable development; Community engagement; South Odisha

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1 Introduction

In the region of South Odisha, India, with a profound amalgamation of various cultural diversity harmonizes with ecological significance, there is a challenge that set back the path to achieve a comprehensive socio-economic development—with a limited access to clean energy. The reality of the region of South Odisha focuses on the problems related to access to clean energy, clean air, proper sanitation, health and quality education. The International Energy Agency (IEA) undertook a study and found out that there is a disparity in the energy access in the region. Though there is availability of infrastructure for electrification but the rural people still faces a unreliable and insufficient energy supply. This leads to poor quality of life and other household problems.

2.1 The Role of Entrepreneurs in Clean Energy Adoption

Entrepreneurs are crucial in scaling sustainable energy adoption in the rural areas of South Odisha. Clean energy entrepreneurship acts as a transformative catalyst, addressing key energy access issues and meanwhile fostering economic growth. Research indicates that local social entrepreneurs are experts at bridging the gaps in the deployment, distribution, installation, and maintenance of clean energy technologies in rural regions. This form of entrepreneurship drives paradigm shifts in societal energy consumption patterns. More than just aiming for profit, these entrepreneurs function as change agents, leading communities towards sustainable energy practices.

2.2 Framework on the Role of Clean Energy Entrepreneurs in Adoption of Clean Energy Technologies

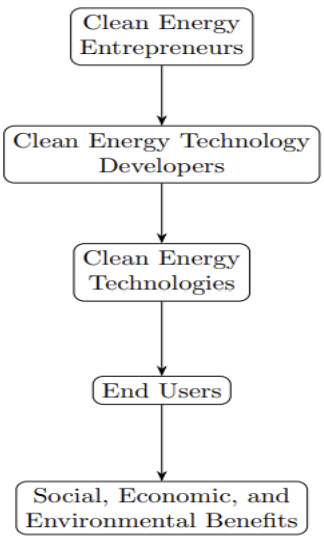

Fig. 1. Framework on the Role of Clean Energy Entrepreneurs

In this sense, clean energy entrepreneurs are the innovators and change-makers who will recognize, create, and carry out programs to encourage the use of renewable energy as shown in Fig. 1. They seek chances, coming up with creative solutions, and handling the complex

terrain of clean energy development should be their main duties. Entrepreneurs focusing on the clean energy sector must take on a variety of tasks, including initiating of businesses, framing of business plans, involved in the community development, and fostering technology advancements for sustainable energy solutions. In order to provide practical, efficient, and sustainable solutions, entrepreneurs rely on the technological breakthroughs and advances offered by producers of clean energy technology.

From the framework it is devised that end users are those who buy the clean energy products and they use the clean energy products and maintain it. Clean energy technology developers are those who produce clean energy products, they focus on standardization and quality aspect and sells, export and import clean energy products and also Develops delivery mechanism along with serviceability for the products. Social, economic and environmental benefits focus on the advantages of using the clean energy products in the various aspects.

2.3 Case Study Role of Clean Energy Entrepreneurs in Adoption of Clean Energy Technologies

2.3.1 From Sunlight to Sustainability: Lighting Up Rural Odisha with Arjun's Vision

Mr. Arjun Patnaik, a determined entrepreneur from Odisha, founded OdishaSun Power Solutions with the purpose of providing clean and sustainable energy to the the state's rural areas. Arjun recognized the energy issues in distant villages and installed solar microgrids to supply electricity for lighting, household appliances, and social areas. He also started community involvement initiatives to teach communities about the benefits of renewable energy and how to make the best use of existing resources. The adoption of solar microgrids empowered communities by increasing access to electricity, which improved education, healthcare, and overall quality of life. Local businesses did very well due to reliable and timely electricity access. Arjun's initiative generated decent employment opportunities, which in turn helped improve the area's economy. By transitioning and moving from conventional energy sources to solar power, Arjun reduced carbon emissions significantly. This also aligned with Odisha's environmental sustainability goals.

As usual, funding has always been a challenge, and more so if the business is not in Tier 1 city. Arjun also faced challenges in securing the initial funding. It is verg important to set up solar microgrids in remote regions and locations. This slowed the adoption of clean energy technologies to a large extent. Like most of us, a few of the communities were initially skeptical about the reliability and benefits of solar power. Overcoming traditional beliefs and gaining community trust required persistent effort by Arjun. Ensuring the consistent and regular operation of solar microgrids was really tough due to the shortage of skilled personnel. Spare parts were also not readily available in rural areas, which is another challenge. These challenges raise concerns about the long-term sustainability of the idea, the project and the business. To address these issues and find a solution, Arjun organized awareness campaigns and community meetings to counter criticism, increase awareness, emphasize the long-term benefits of solar energy. He also collaborated with local leaders to build trust and sought partnerships with NGOs. He also applied for government programs to secure initial funding. Additionally, he developed a community-based payment system to make solar energy affordable and convenient for low-income households. Arjun trained residents to perform basic repairs which will make them less dependent on service centres and skilled manpower, ensuring the long term sustainability of the solar microgrids through a decentralized approach. Meanwhile, Arjun also set up local service centers to address critical maintenance issues.

2.3.2 Solar-Powered Agri-pesticide Sprayer

A solar powered smart Agri-pesticide sprayer was also designed for ease of spraying at the fields. For better health and agricultural output, having access to cutting-edge technology-oriented energy services is vital. The use of a solar-powered smart Agri-pesticide sprayer helped in reducing drudgery for rural farmers and subsequently helped in enhancing the yield. The sprayer included a solar panel, battery, charge controller, DC pump, and spraying system. It was a simple, portable, easy to use, and did not require any complex technical know-how. The system was powered by solar energy. It was pollution-free and requires low maintenance costs.

The system basically consisted of a solar panel, a battery, a charge controller and an MCB. The system starts when the MCB is turned on. The DC motor helped in ejecting the required amount of pesticide from the tank through the nozzle. This in turn resulted in sprinkling of the pesticide by the help of the sprayer. All the components are stacked onto a stainless steel made cart. During the experimental set-up it was also revealed that the discharge rate of fluid at the outlet of the DC Pump and nozzle varied. By combining the solar panel of 20W, battery of 12V and 7.2Ah, a charge controller of 12V, 10A and a DC pump, the highest discharge rate at the DC pump's output was found to be 4.3 liters per minute with 12V, 4.2 LPM.

It was found that the DC pump and sprayer offered a maximum efficiency of 75% and 25%, respectively. The pesticide sprayer's performance coefficient was determined at 0.33. The system characteristics such as the size of the solar panels and battery, energy consumption, performance ratio, and energy loss were determined by simulation using PVSYST software utilizing the local geographical data of the region. The geographical region was Bhubaneswar, the capital city of Odisha, located at the eastern part of India. Since the system was powered by solar energy, it emitted no pollutants. Apart from being technologically efficient, it was more advantageous when compared to a traditional sprayer in terms of expensiveness and portability.

Apart from using the system as a pesticide sprayer, it was used for a variety of purposes. It included a charging station for a mobile phone and points for recharging of LEDs. It can be operated at night or in cloudy conditions by using a battery and charge controller. The microcontroller could be modified further to govern the movement of the wheel and the sprinkling operation. When compared to diesel and hand-operated sprayers, the system was pollution-free and ecologically sound. Rural farmers can rent the system ranging from an hourly basis to a monthly basis depending upon the requirements of the farmer. Further, a focused group discussion was held with some farmers who used the system, from Limma village of Kundura tehsil. It was found that the system was easy to use, portable and helped in reducing drudgery. They did not depend on diesel for using the system, further, which led to enhancing their income. The system helped in enhancing the rural farmers' health and

livelihoods, as well as generate revenue and improving the quality of life. Fig 2 shows the modelling of the system.

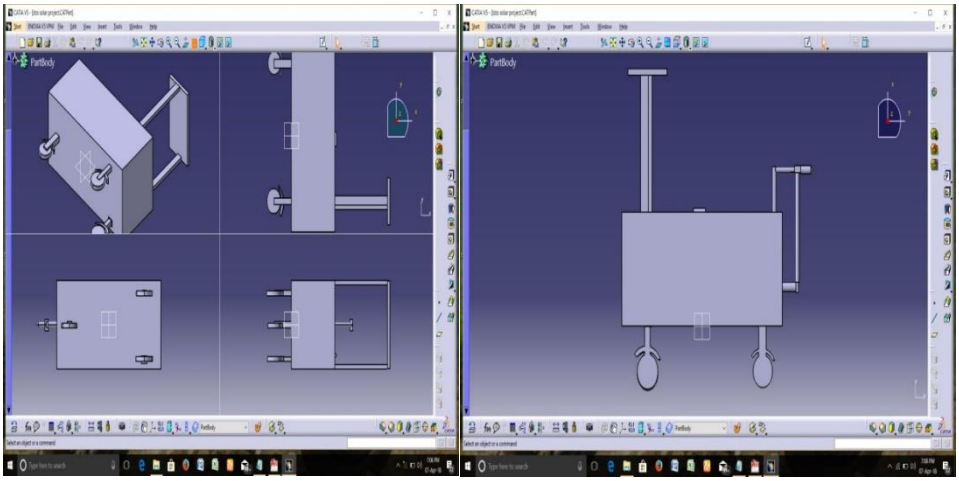

Fig. 2. Modelling of Spraying System by Catia Software

The battery is charged by the control charger after the solar panel stores the solar radiation as DC energy. The charge controller disconnects the connection from the panels to the battery when the battery charge is full and overloaded, preventing the battery from being damaged. Currently, the battery uses the MCB switch to send the stored energy to the pump. One of the charge controller's positive connections goes to the MCB switch, and the other end of the connection, which is attached to the pump, comes out of the switch. The DC pump receives one of the negative connections from the charge controller.

3 Conclusion

In conclusion, the case study focuses on the transformative potential of clean energy initiatives in rural and urban landscapes. There is a need to focus on a ecosystem framework that will help in adoption of clean energy products in the rural areas. There is a need to focus on collaborative efforts at every level starting from the policy level to implementation level. We need to create a sense of ownership and thought for adoption of these clean energy products.

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